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FINAL REPORT ON THE SUCCESS OF LARGEMOUTH BASS-BLUEGILL AND LARGEMOUTH BASS-SHELL- CRACKER RATES AND RATIOS IN KENTUCKY FARM PONDS

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ABSTRACT

In order to test the relative success of various stocking rates of largemouth bass, *Micropterus salmoides* (Lacepede)-bluegill, *Lepomis macrochirus* Rafinesque, combinations and largemouth bass-shellcracker, *Lepomis microlophus* (Gunther), in farm ponds in Kentucky, 574 ponds were stocked with these fishes in the following combinations and rates: fry bass: fingerling bluegill 30:400, 50:500, 80:500 and 100:500 per acre; fry bass: adult bluegill 100:30, 100:50 and 100:70 per acre; fry bass: fingerling shellcracker 50:300 and 50:600 per acre; fry bass; fingerling shellcracker + mosquito fish, *Gambusia affinis* (Baird and Girard), 50:300 + 400 and 50:600 + 400 per acre.

In each year from 1952 through 1956, a series of ponds was stocked. No pond was stocked more than once nor with more than one rate. Bass-bluegill combinations were stocked in each of the first four years, the shellcracker combinations in 1953, 1955 and 1956.

Each pond was investigated annually and the success of each rate was determined by the percentage of balanced ponds that the rate produced.

No significant differences in percentage of success were found among the following bass-bluegill rates: 80:500, 100:500 (fry bass: fingerling bluegill), 100:30, 100:50, and 100:70 (fry bass: adult bluegill).

The most successful bass-shellcracker rate could not be determined because of the large number of ponds that failed to produce reliable data.

A total of 384 or 66.9% of the ponds stocked failed to yield reliable data and were discontinued during the investigation. The invasion of the ponds by other fish was the principal reason that these ponds were discontinued.

INTRODUCTION

Accepted stocking rates and ratios successful in other areas, have failed to produce satisfactory results in Kentucky ponds. In November of 1951, the Department of Fish and Wildlife Resources initiated a project, as part of the Federal Aid to Fisheries program, designed to aid in establishing more successful rates and ratios for Kentucky farm ponds.

The project was divided into two phases. The first phase was completed in 1953 and the findings were published in 1955 by Smith, Kirkwood, and Hall. A brief history of Kentucky's farm pond program was presented in this report and will not be repeated here but will be used in reference.

The first phase and part of the second phase of the project were under the leadership of William A. Smith, Jr. The author of the present report became project leader on March 1, 1956.

The second phase of the project consisted of investigations to determine the success of various rates and ratios of largemouth bass and bluegill and of largemouth bass and shellcracker in Kentucky farms ponds. To accomplish this, a series of bass-bluegill combinations were stocked in each of the following years: 1952, 1953, 1954, and 1955. A series of bass-shellcracker combinations were stocked in 1953, 1955, and 1956. Each pond was investigated once each year (a few exceptions will be discussed later) from the time of stocking until the termination of the project in April, 1958.

In this report, data on the bass-bluegill series will be presented separately from data on the bass-shellcracker investigations.

MATERIALS AND METHODS

Selection of Rates

The rates and ratios listed below were selected in the following manner: Meetings were held by Kentucky fishery personnel and personnel from other states and several rates were suggested; several rates that had been successful in Kentucky and other states were examined; rates that had been successfully used by the U. S. Fish and Wildlife Service were examined and recorded, and data collected during the first phase of the project was evaluated. After analysis and evaluation of the data from these sources the following rates were selected.

<i>Rate (Per Acre)</i>		<i>Ratio (Approximately)</i>
<i>Fry Bass : Fingerling Bluegill</i>		
30	: 400	1 : 13
50	: 500	1 : 10
80	: 500	1 : 6
100	: 500	1 : 5
<i>Fry Bass : Adult Bluegill</i>		
100	: 30	3 : 1
100	: 50	2 : 1
100	: 70	1½ : 1

Data collected during the first phase of the project revealed that many marginal ponds tend to become overpopulated with bluegill when stocked with this species. It was suggested that this type of pond might be more successful if stocked with bass-shellcracker combinations. The following rates were then added to the study:

<i>Rate (Per Acre)</i>		<i>Ratio</i>
<i>Fry Bass</i>	<i>: Fingerling Shellcracker</i>	
50	: 300	1 : 6
50	: 600	1 : 12
50	: 300 + 400 <i>Gambusia</i>	
50	: 600 + 400 <i>Gambusia</i>	

Past results indicated that shellcracker did not produce sufficient forage during the first summer to promote the desired growth of bass, therefore, mosquito fish were thereafter added to half of the ponds stocked in order to supplement the bass food supply. All rates were stocked on a per acre basis.

Soils Region Division

During the first phase of the project, the state was divided into six major soils regions (Figure 1).

These regions are:

1. Jackson Purchase: The Purchase consists of that portion of Kentucky lying west of the Tennessee River. Here most of the soils are derived from loess which ranges from 2 to 20 feet in thickness, and if unlimed are moderately to strongly acidic. They are low in phosphates, but not as much so as the other soils outside of the Bluegrass area.

2. Western Coalfields: In this region the upland soils are derived from sandstone and shale. They are low in phosphates and usually moderately to strongly acidic. Considerable loess has been deposited in that part of the area adjacent to the Ohio River, but this and the overflow area contain few farm ponds.

3. Pennyroyal: The soils of this region are derived from sandstone, shales and limestone, either singly or in various combinations. All are slightly to strongly acidic and low in phosphates. The topography is generally sloping to hilly.

4. Outer Bluegrass: In this region the topography is rolling to hilly. The soil is derived from limestone and calcareous shales, with the latter predominating in the outer sections. The majority of the soils range from slightly to moderately acidic.

5. Inner Bluegrass: This region is well known for its productive soils derived from phosphatic limestone. Topographically it consists of gently rolling upland.

6. Eastern Coalfields: This region is typified by rugged and partly mountainous topography with very little bottom land. The soils are derived from sandstone and some shales. The greater portion of the area is in forest and not suitable for agriculture. Few farm ponds are located in this section, most of them being confined to a few southern counties.

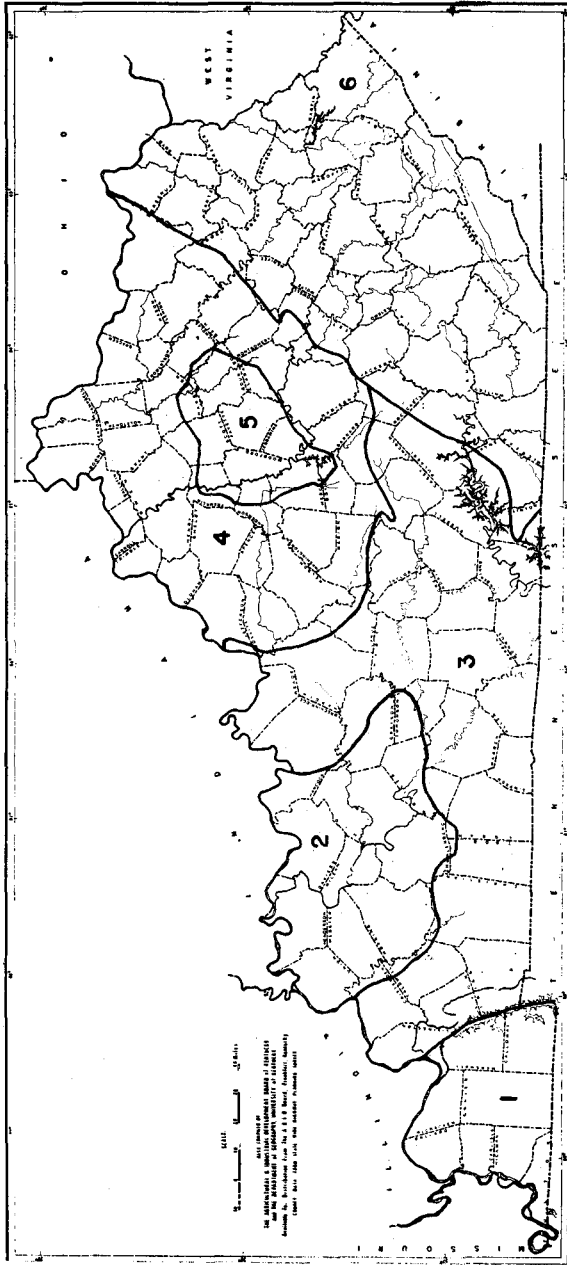
Selection of Ponds

The ponds for the 1952 series were selected directly from stocking applications received by the Department in 1951. This method proved to be unsatisfactory because of errors in size estimations by owners or conservation officers, and because many ponds were found to be inaccessible. All ponds stocked in 1953 and thereafter were first inspected by project personnel.

Ponds were selected during the fall and winter preceding each stocking series. Each month new stocking applications were examined and ponds one-half acre or larger were recorded along with names and addresses of owners. Conservation officers in the counties where the ponds were located were contacted and a meeting was arranged between project personnel and each pond owner.

The purpose of the meeting was explained to the pond owner and permission was obtained to use the pond for experimental purposes. The pond was then inspected to see if it satisfied the following conditions: It must contain no fish (*i. e.*, the pond must be either newly constructed or renovated), it must be classifiable as manageable or marginal (see classification of ponds), it must be

Fig. 1. MAJOR PHYSICAL DIVISIONS OF KENTUCKY



Legend

- 1. Jackson Purchase
- 2. Western Coalfields
- 3. Pennyroyal
- 4. Outer Bluegrass
- 5. Inner Bluegrass
- 6. Eastern Coalfields

between 0.5 and 15 acres in size (later reduced to 8 acres) as measured by pacing to the nearest 0.1 acre, it must be fairly easy to seine, it must be readily accessible.

If the pond or ponds were found satisfactory, the inspecting party explained to the owner that the pond would be placed on a special stocking list and that fishery personnel would bring the fish directly to the pond rather than to a centrally located spot in the county as was the usual procedure on regular stocking deliveries. The location of the pond and other pertinent information was recorded and a crude map of directions to the pond was drawn. This map was found to be valuable in locating ponds later, especially when the conservation officer was not available. After all ponds had been selected, the locations were classified as to soils regions and the stocking rates were distributed equally among the six regions.

Classification of Ponds

Manageable Ponds

1. Adequate depth for continuous growth and carry-over of fish through periods of low rainfall (depends on water supply).
2. A relatively stable water level.
3. Moderate to nonexistent overflow of water from pond.
4. Absence of large areas of extremely shallow water.
5. Clear water except following extremely heavy rains.

Marginal Ponds

1. Inadequate depth for continuous growth of bass and bluegill during moderately dry periods.
2. Widely fluctuating water level.
3. Subject to heavy overflow of water during winter and early spring, resulting in an excessive loss of nutrients and adult fish.
4. Extensive areas of shallow water that hamper predator control of forage species and promote growth of emergent weeds.
5. Moderate siltation resulting in retardation of bass and bluegill growth, bass reproduction not being greatly affected.

Unmanageable Ponds

1. Inadequate depth for carry-over of the bass-bluegill population during prolonged periods of little or no rainfall.
2. Extreme water level fluctuation such that bluegill and/or bass growth is severely retarded for prolonged periods.
3. Pond subject to heavy overflow of water during major portion of growing season, resulting in severe loss of adult fishes and nutrients.
4. Major areas of pond consisting of water too shallow for efficient control of emergent and submergent weeds.
5. Extreme siltation resulting in severely retarded growth of bass and bluegill and greatly curtailed or suspended bass reproduction.

Stocking

Bass-bluegill combinations were stocked in the spring, bluegill in March and April and bass the following May, except the 1952 series, in half of which the bluegill were stocked in the fall of 1951 and the bass in the spring of 1952. All fish were hand counted and delivered directly to the pond by fishery personnel. No pond was stocked more than once nor with more than one rate.

Bluegill stocked in the spring as fingerlings were 2-3 inches in length and those stocked as adults were 4-6 inches. Bass were stocked as advanced fry (about 1" in length).

Bass-shellcracker combinations were stocked in the same manner except that only fingerling shellcracker were used, and they were stocked in the fall (October through December). Bass fry were stocked the following spring. *Gambusia* were added to the ponds at approximately the same time as the shellcracker.

Bluegill and shellcracker stock for the 1952, 1953, and 1954 series were obtained from the U. S. Fish and Wildlife Service Hatchery at Corning, Arkansas,

and from private ponds. Bass were obtained from state-owned hatcheries except in 1953, when they were procured from a Michigan hatchery. Stock for the 1955 and 1956 series were obtained from the U. S. Fish and Wildlife Service hatchery at Frankfort, Kentucky. *Gambusia* were raised by project personnel in private ponds near Louisville, Kentucky.

At the time of each stocking, the level of the pond was recorded; also any defects, such as leaks or spillway damage, that had occurred since the original inspection were noted.

Collection of Data

The collection of field data began about the second week in June or just after the bluegill started spawning and ended around September 30. Ponds in the 1954, 1955, and 1956 series were test-seined the first summer following stocking in order to detect the presence of adult fishes, other than those stocked, that had entered the pond from the watershed or drainage area. This first summer's test seining could not be done in 1952 and 1953 because of the time needed for other phases of the project.

Investigations were conducted each year by two field teams, consisting of a biologist and field assistant each. Populations were examined with a 1/4-inch mesh, 30' x 6', minnow seine, a small mesh fry seine, 8' x 4', made of bobbinet cloth, and a 1 1/4-inch mesh seine, 75' x 10' (this seine was not used in the 1956 and 1957 seasons except to collect scale samples for growth studies). In each pond, 3 hauls, averaging 40 feet of shoreline in length, were made with the 30-foot seine; 5 hauls, averaging 10 feet of shoreline, were made with the fry seine, and 2 hauls, averaging 100 feet of shoreline, were made with the 75-foot seine. The length of these seine hauls varied somewhat because of the size and topography of the ponds. Numbers and size groups for each species in each seine haul were recorded and the pond was classified as balanced, overpopulated with bluegill, or overpopulated with bass at that time. Other pertinent information that might aid in population analysis was also recorded. Figure 2 shows the type of form used to record this data.

FIGURE 2. FRONT SIDE OF FIELD DATA FORM

Department of Fish and Wildlife Resources, Frankfort, Kentucky
 Farm Pond Investigation
 Project F-3-R

Soils Group _____ County _____ File No. _____
 Name _____ Address _____ Size _____ Ratio _____
 Color of Pond _____ Cause _____
 Seechi disk reading _____ ins. Time _____ Weather Con'd. _____
 Present status: Manageable _____ Marginal _____ Unmanageable _____
 Reason _____
 Present size _____ Present water level _____
 Fishing: Good _____ Poor _____ Fishing Effort _____
 Species, Number, Length or Weight of Fish Caught _____
 Weeds _____
 Other influencing factors _____

Analysis of Population:
 Bluegill Spawn: Heavy _____ Medium _____ Light _____ Absent _____
 Conditions of Adult Blg. _____ No. of Intermediates _____
 Bass Spawn: Heavy _____ Medium _____ Light _____ Absent _____
 Condition of Adult Bass _____
 State of Balance _____ Disposition _____
 Reason _____ Scale Sampling _____
 Recommendations _____
 Remarks _____
 Date Checked _____ Investigators _____

It is generally agreed that there are many degrees of balance and unbalance in ponds and no definite combinations of numbers can be set to designate this degree of balance. In these investigations, however, the range of numbers generally found in balanced ponds was between 6 and 25 intermediate bluegills and 2 or more young-of-the-year bass per drag of the 30-foot seine. In the fry seine the range was between 50 and 1,000 fry bluegill per drag. Bluegill

between 2 and 5 inches long were classified as intermediates and fry bluegill refers to any bluegill 1 inch or less in length.

Ponds were classified as balanced when an adequate number of young bass and young bluegill, along with a moderate number of intermediate bluegill, were found to be present as evidenced by the seine hauls.

Ponds were classified as overpopulated with bluegill when the number of young bluegill or the number of young bass was inadequate and the number of intermediate bluegill was excessive.

Ponds were classified as overpopulated with bass when the seines failed to capture an adequate number of intermediate bluegill.

If the investigators were unable to judge the population as either balanced or unbalanced, the pond was placed in an undetermined category. If doubt still remained after two consecutive yearly checks, it was discontinued as an experimental pond.

Ponds which failed to yield any pertinent information at the time of investigation and failed to show promise of yielding any such information, were discontinued and were not checked thereafter.

BASS-BLUEGILL INVESTIGATIONS

Rate Distribution

A total of 514 ponds were stocked with bass-bluegill combinations during the 5-year investigation (Table I). Twenty-four of these ponds were stocked with various rates that were later discontinued. The remaining 490 ponds were stocked with one of the 7 rates described earlier in this report.

TABLE I
RATE DISTRIBUTION OF BASS-BLUEGILL PONDS

Soils Region	Series	Fry Bass:				Fry Bass:			Totals
		Fingerling Bluegill				Adult Bluegill			
		30:400	50:500	80:500	100:500	100:30	100:50	100:70	
	52	1	4	--	1	4	6	4	20
Outer	53	4	6	3	4	7	7	4	35
Bluegrass	54	7	4	5	4	5	5	5	35
	55	12	14	10	11	11	15	12	85
	52	1	1	1	--	5	--	6	14
Inner	53	1	1	--	1	1	1	3	8
Bluegrass	54	3	1	2	3	2	1	3	15
	55	2	1	1	2	4	2	1	13
	52	--	4	3	1	5	6	6	25
Eastern	53	--	1	1	1	5	5	3	16
Coalfields	54	3	2	2	3	3	4	3	20
	55	5	6	5	5	4	5	5	35
	52	1	--	1	1	--	--	--	3
Western	53	1	1	2	1	1	--	--	6
Coalfields	54	2	2	2	1	2	2	2	13
	55	3	4	4	5	3	3	3	25
	52	3	--	5	6	2	2	1	19
Penny-	53	2	--	4	3	1	--	1	11
royal	54	2	2	3	3	3	2	2	17
	55	8	7	10	10	6	10	9	60
	52	1	1	--	1	--	--	1	4
Jackson	53	--	--	--	--	--	1	1	2
Purchase	54	--	--	--	--	--	--	--	0
	55	1	2	1	--	2	2	1	9
	52	7	10	10	10	16	14	18	85
All	53	8	9	10	10	15	14	12	78
Regions	54	17	11	14	14	15	14	15	100
	55	31	34	31	33	30	37	31	227
TOTALS	---	63	64	65	67	76	79	76	490

No ponds were selected from the Jackson Purchase region in 1954, because of the distance of this region from the central office. In 1955, ponds were selected from this region again in order to get a maximum number of ponds.

History of the 1952 Series

In this series 89 ponds were stocked. About one-half of these ponds were stocked with bluegill in the fall of 1951 and bass the following spring. The other one-half were stocked with both bass and bluegill in the spring of 1952. A history of this series is shown in Table II.

TABLE II
HISTORY OF THE 1952 SERIES
(The Figure in Parenthesis Represents Percent [%])

<i>Status</i>	<i>Status in 1953, 89 Ponds</i>			<i>Totals</i>
	<i>Manageable</i>	<i>Marginal</i>	<i>Unclassified</i>	
Balanced	3 (60)	7 (64)	1 (100)	11 (65)
Overpopulated Bluegill	1 (20)	4 (36)	-	5 (29)
Overpopulated Bass	1 (20)	-	-	1 (6)
Not Checked	-	-	11	11
Undetermined	-	-	10	10
Discontinued*	-	-	-	0
TOTALS	5	11	22	38

<i>Status</i>	<i>Status in 1954, 89 Ponds</i>			<i>Totals</i>
	<i>Manageable</i>	<i>Marginal</i>	<i>Unclassified</i>	
Balanced	7 (64)	3 (38)	1 (17)	11 (44)
Overpopulated Bluegill	3 (27)	4 (50)	1 (17)	8 (32)
Overpopulated Bass	1 (9)	1 (13)	4 (67)	6 (24)
Not Checked	-	-	2	2
Undetermined	-	-	2	2
Discontinued	-	-	60	60
TOTALS	11	8	70	89

<i>Status</i>	<i>Status in 1955, 29 Ponds</i>			<i>Totals</i>
	<i>Manageable</i>	<i>Marginal</i>	<i>Unclassified</i>	
Balanced	1 (25)	4 (50)	2 (50)	7 (44)
Overpopulated Bluegill	3 (75)	3 (38)	-	6 (38)
Overpopulated Bass	-	1 (13)	2 (50)	3 (19)
Not Checked	-	-	2	2
Discontinued	-	-	11	11
TOTALS	4	8	17	29

<i>Status</i>	<i>Status in 1956, 18 Ponds</i>			<i>Totals</i>
	<i>Manageable</i>	<i>Marginal</i>	<i>Unclassified</i>	
Balanced	3 (38)	3 (50)	-	6 (43)
Overpopulated Bluegill	4 (50)	2 (33)	-	6 (43)
Overpopulated Bass	1 (13)	1 (17)	-	2 (14)
Discontinued	-	-	4	4
TOTALS	8	6	4	18

<i>Status</i>	<i>Status in 1957, 14 Ponds</i>			<i>Totals</i>
	<i>Manageable</i>	<i>Marginal</i>	<i>Unclassified</i>	
Balanced	-	3 (50)	1 (33)	4 (31)
Overpopulated Bluegill	3 (75)	1 (17)	1 (33)	5 (39)
Overpopulated Bass	1 (25)	2 (33)	1 (33)	4 (31)
Undetermined	-	-	1	1
TOTALS	4	6	4	14

* No ponds were discontinued in 1953.

In the following tables of histories, the ponds are classified into three groups—manageable, marginal, and unclassified. The unclassified category contains those ponds (either manageable or marginal) from which data were collected but could not be accurately compared with the data collected from the other manageable and marginal ponds. These unclassified ponds were extremely weedy, had very little shallow area (not enough for adequate bluegill reproduction) or were larger or smaller than was reported in the original write-up sheet, and therefore, had not been accurately stocked.

The ponds listed as "not checked," were ponds which the investigators were unable to visit because of impassable roads or barriers, or in one or two cases were overlooked when the summer work schedule was planned. These ponds were investigated the following year, if possible, and if they were found to be inaccessible again they were discontinued as experimental ponds.

History of the 1953 Series

The 1953 series contained 98 ponds (Table III). Several ponds in this series and the following series were discontinued because of fish kills or renovation at the owner's request. For this reason the total figures are sometimes different than those in the table heading.

TABLE III
HISTORY OF THE 1953 SERIES
(The Figure in Parenthesis Represents Percent [%])

Status	Status in 1954, 98 Ponds			Totals
	Manageable	Marginal	Unclassified	
Balanced	4 (80)	5 (42)	—	9 (45)
Overpopulated Bluegill	—	6 (50)	1 (33)	7 (35)
Overpopulated Bass	1 (20)	1 (8)	2 (67)	4 (20)
Not Checked	—	—	1	1
Undetermined	—	—	26	26
Discontinued	—	—	52	52
TOTALS	5	12	82	99*

* 1 pond was discontinued after data compiled.

Status	Status in 1955, 46 Ponds			Totals
	Manageable	Marginal	Unclassified	
Balanced	7 (47)	4 (50)	2 (40)	13 (46)
Overpopulated Bluegill	5 (33)	3 (38)	2 (40)	10 (36)
Overpopulated Bass	3 (20)	1 (12)	1 (20)	5 (18)
Not Checked	—	—	4	4
Undetermined	—	—	2	2
Discontinued	—	—	17	17
TOTALS	15	8	28	51*

* 5 ponds were discontinued after data compiled.

Status	Status in 1956, 29 Ponds			Totals
	Manageable	Marginal	Unclassified	
Balanced	9 (64)	2 (25)	3 (100)	14 (56)
Overpopulated Bluegill	4 (29)	5 (62)	—	9 (36)
Overpopulated Bass	1 (7)	1 (12)	—	2 (8)
Discontinued	—	—	6	6
TOTALS	14	8	9	31*

* 2 ponds were discontinued after data compiled.

Status	Status in 1957, 23 Ponds			Totals
	Manageable	Marginal	Unclassified	
Balanced	6 (46)	5 (62)	2 (100)	13 (57)
Overpopulated Bluegill	5 (39)	3 (37)	—	8 (34)
Overpopulated Bass	2 (15)	—	—	2 (8)
Discontinued	—	—	1	1
TOTALS	13	8	3	24*

* 1 pond was discontinued after data compiled.

During 1953, and again in 1954, the whole state was affected by a severe drought. Many ponds went dry and almost all became lower than usual. As a result the bass failed to spawn in many ponds at the end of the first year. However, the ponds were not necessarily overpopulated and were placed in the undetermined category. In 1955 these ponds again filled to normal levels and many contained balanced populations.

History of the 1954 Series

The 1954 series contained 100 ponds. The history of this series is shown in Table IV.

TABLE IV
HISTORY OF THE 1954 SERIES
(The Figure in Parenthesis Represents Percent [%])

Status	Status in 1955, 100 Ponds			
	Manageable	Marginal	Unclassified	Totals
Balanced	8 (42)	12 (71)	3 (60)	23 (56)
Overpopulated Bluegill	4 (21)	4 (24)	1 (20)	9 (22)
Overpopulated Bass	7 (37)	1 (6)	1 (20)	9 (22)
Not Checked	-	-	3	3
Undetermined	-	-	11	11
Discontinued	-	-	50	50
TOTALS	19	17	69	105*

* 5 ponds were discontinued after data compiled.

Status	Status in 1956, 50 Ponds			
	Manageable	Marginal	Unclassified	Totals
Balanced	14 (64)	8 (62)	2 (50)	24 (62)
Overpopulated Bluegill	4 (18)	3 (23)	2 (50)	9 (23)
Overpopulated Bass	4 (18)	2 (15)	-	6 (15)
Undetermined	-	-	4	4
Discontinued	-	-	9	9
TOTALS	22	11	17	52*

* 2 ponds were discontinued after data compiled.

Status	Status in 1957, 41 Ponds			
	Manageable	Marginal	Unclassified	Totals
Balanced	12 (52)	2 (18)	1 (25)	15 (40)
Overpopulated Bluegill	3 (13)	6 (55)	2 (50)	11 (29)
Overpopulated Bass	8 (35)	3 (27)	1 (25)	12 (32)
Undetermined	-	-	2	2
Discontinued	-	-	3	3
TOTALS	23	11	9	43*

* 2 ponds were discontinued after data compiled.

History of the 1955 Series

This series was the largest of the four. An intensive effort was made by each member of the project to obtain for the study as many ponds as possible. As a result 227 ponds were selected from the six soils regions. It should be emphasized that this series of ponds is the only series that was not adversely affected by extremes in climatic conditions. The history of this series is shown in Table V.

TABLE V
HISTORY OF THE 1955 SERIES
(The Figure in Parenthesis Represents Percent [%])

Status	Status in 1956, 227 Ponds			Totals
	Manageable	Marginal	Unclassified	
Balanced	32 (55)	13 (32)	5 (33)	50 (44)
Overpopulated Bluegill	21 (36)	23 (56)	5 (33)	49 (43)
Overpopulated Bass	5 (9)	5 (12)	5 (33)	15 (13)
Not Checked	-	-	2	2
Undetermined	-	-	12	12
Discontinued	-	-	100	100
TOTALS	58	41	129	228*

* 1 pond was discontinued after data compiled.

Status	Status in 1957, 127 Ponds			Totals
	Manageable	Marginal	Unclassified	
Balanced	32 (60)	15 (37)	6 (33)	56 (48)
Overpopulated Bluegill	19 (33)	20 (49)	5 (28)	44 (38)
Overpopulated Bass	4 (7)	6 (15)	7 (39)	17 (15)
Undetermined	-	-	3	3
Discontinued	-	-	10	10
TOTALS	58	41	31	130*

* 3 ponds were discontinued after data compiled.

Success of Rates

The success of the seven rates in manageable and marginal ponds combined is shown in Table VI, success being relative to the percentage of balanced ponds. All four series (1952, 1953, 1954 and 1955) are combined to show success at the end of the first and second years. Success for ponds 3 years old excludes the 1955 series, which was not yet 3 years old at the termination of the project. Success for ponds 4 years old includes only the 1952 and 1953 series and success for ponds 5 years old includes only the 1952 series.

TABLE VI
SUCCESS OF RATES FOR ALL SERIES OF MANAGEABLE AND MARGINAL PONDS
(COMBINED) ONE, TWO, THREE, FOUR AND FIVE YEARS AFTER STOCKING
(The Figure in Parenthesis Represents Percent [%])

Status	One Year							Totals
	Fry Bass:Fingerling Bluegill				Fry Bass:Adult Bluegill			
	30:400	50:500	80:500	100:500	100:30	100:50	100:70	
Balanced	8(32)	9(43)	14(58)	10(39)	11(52)	20(64)	12(60)	84(50)
Overpopulated Blg.	17(68)	12(57)	8(33)	10(39)	4(19)	9(29)	3(15)	63(37)
Overpopulated Bass	-	-	2(8)	6(23)	6(29)	2(6)	5(25)	21(12)
TOTALS	25	21	24	26	21	31	20	168
	Two Years							
Balanced	7(32)	7(39)	18(69)	16(64)	11(50)	20(56)	14(56)	93(53)
Overpopulated Blg.	15(68)	8(44)	5(19)	7(28)	7(32)	11(31)	7(28)	60(35)
Overpopulated Bass	-	3(17)	3(12)	2(8)	4(18)	5(14)	4(16)	21(12)
TOTALS	22	18	26	25	22	36	25	174
	Three Years							
Balanced	4(57)	3(60)	3(30)	3(33)	8(67)	3(37)	6(35)	30(44)
Overpopulated Blg.	3(43)	1(20)	4(40)	5(56)	-	2(25)	9(53)	24(35)
Overpopulated Bass	-	1(20)	3(30)	1(11)	4(33)	3(37)	2(12)	14(21)
TOTALS	7	5	10	9	12	8	17	68

TABLE VI—Continued

SUCCESS OF RATES FOR ALL SERIES OF MANAGEABLE AND MARGINAL PONDS
(COMBINED) ONE, TWO, THREE, FOUR AND FIVE YEARS AFTER STOCKING
(The Figure in Parenthesis Represents Percent [%])

Status	Four Years							Totals	
	Fry Bass:Fingerling Bluegill				Fry Bass:Adult Bluegill				
	30:400	50:500	80:500	100:500	100:30	100:50	100:70		
Balanced	2(67)	1(25)	1(25)	1(33)	5(71)	3(60)	4(44)	17(49)	
Overpopulated Blg.	1(33)	2(50)	2(50)	2(67)	1(14)	2(40)	4(44)	14(40)	
Overpopulated Bass	—	1(25)	1(25)	—	1(14)	—	1(11)	4(11)	
TOTALS	3	4	4	3	7	5	9	35	
Status	Five Years							Totals	
	Balanced	—	—	2(100)	1(100)	—	—		3(30)
	Overpopulated Blg.	—	1(50)	—	—	1(50)	—		2(67)
	Overpopulated Bass	—	1(50)	—	—	1(50)	—		3(30)
	TOTALS	—	2	2	1	2	—		3

For all ponds the most successful rates were 100:50 (ratio, 2:1) which was 64% successful at the end of the first year after stocking and 56% successful at the end of the second year after stocking, and 80:500 (ratio 1:6) which was 58% successful the first year and 69% successful the second year.

The success of each rate in manageable ponds is shown in Table VII. The rates with the highest percentage of success for this type of pond were also 100:50, 72%, first and 73%, second year and 80:500, 56%, first and 71%, second year.

TABLE VII

SUCCESS OF RATES FOR ALL SERIES (COMBINED) IN MANAGEABLE PONDS
ONE, TWO, THREE, FOUR AND FIVE YEARS AFTER STOCKING

Status	One Year							Totals	
	Fry Bass:Fingerling Bluegill				Fry Bass:Adult Bluegill				
	30:400	50:500	80:500	100:500	100:30	100:50	100:70		
Balanced	3(25)	6(67)	5(56)	5(39)	7(58)	13(72)	8(57)	47(54)	
Overpopulated Blg.	9(75)	3(33)	4(44)	4(31)	1(8)	3(17)	2(14)	26(30)	
Overpopulated Bass	—	—	—	4(31)	4(33)	2(11)	4(29)	14(16)	
TOTALS	12	9	9	13	12	18	14	87	
Status	Two Years							Totals	
	Balanced	5(45)	3(37)	12(71)	11(69)	7(47)	16(73)		9(53)
	Overpopulated Blg.	6(54)	2(25)	4(24)	5(31)	5(33)	4(18)		5(29)
	Overpopulated Bass	—	3(37)	1(6)	—	3(20)	2(9)		3(18)
TOTALS	11	8	17	16	15	22	17	106	
Status	Three Years							Totals	
	Balanced	4(57)	2(50)	1(33)	—	7(70)	2(67)		6(60)
	Overpopulated Blg.	3(43)	1(25)	—	3(75)	—	—		3(30)
	Overpopulated Bass	—	1(25)	2(67)	1(25)	3(30)	1(33)		1(10)
TOTALS	7	4	3	4	10	3	10	41	
Status	Four Years							Totals	
	Balanced	—	—	1(50)	—	4(67)	1(100)		3(37)
	Overpopulated Blg.	1(100)	1(50)	1(50)	1(100)	1(17)	—		4(50)
	Overpopulated Bass	—	1(50)	—	—	1(17)	—		1(12)
TOTALS	1	2	2	1	6	1	8	21	
Status	Five Years							Totals	
	Balanced	—	—	—	—	—	—		0
	Overpopulated Blg.	—	1(100)	—	—	—	—		2(67)
	Overpopulated Bass	—	—	—	—	—	—		1(33)
TOTALS	—	1	—	—	—	—	3	4	

Rate success for marginal ponds is shown in Table VIII. The rates with the highest percentage of success for this type of pond were 100:70 (ratio 1½:1) which was 67% successful in the first year and 62% successful the second year, and 80:500 which was 60% and 67% successful for the first and second year investigations.

TABLE VIII
SUCCESS OF RATES FOR ALL SERIES (COMBINED) IN MARGINAL PONDS
ONE, TWO, THREE, FOUR AND FIVE YEARS AFTER STOCKING
(The Figure in Parenthesis Represents Percent [%])

Status	One Year				Fry Bass:Adult Bluegill			
	Fry Bass:Fingerling Bluegill				100:30	100:50	100:70	Totals
	30:400	50:500	80:500	100:500				
Balanced	5(38)	3(25)	9(60)	5(39)	4(44)	7(54)	4(67)	37(46)
Overpopulated Bg.	8(61)	9(75)	4(27)	6(46)	3(33)	6(46)	1(17)	37(46)
Overpopulated Bass	-	-	2(13)	2(15)	2(22)	-	1(17)	7(9)
TOTALS	13	12	15	13	9	13	6	81
<i>Two Years</i>								
Balanced	2(18)	4(31)	6(67)	5(56)	4(57)	4(31)	5(62)	30(43)
Overpopulated Bg.	9(82)	8(62)	1(11)	2(22)	2(29)	6(46)	2(25)	30(43)
Overpopulated Bass	-	1(8)	2(22)	2(22)	1(14)	3(23)	1(12)	10(14)
TOTALS	11	13	9	9	7	13	8	70
<i>Three Years</i>								
Balanced	-	1(100)	2(29)	3(60)	1(50)	1(20)	-	8(30)
Overpopulated Bg.	-	-	4(57)	2(40)	-	2(40)	6(86)	14(52)
Overpopulated Bass	-	-	1(14)	-	1(50)	2(40)	1(14)	5(18)
TOTALS	-	1	7	5	2	5	7	27
<i>Four Years</i>								
Balanced	2(100)	1(50)	-	1(50)	1(100)	2(50)	1(100)	8(57)
Overpopulated Bg.	-	1(50)	1(50)	1(50)	-	2(50)	-	5(36)
Overpopulated Bass	-	-	1(50)	-	-	-	-	1(7)
TOTALS	2	2	2	2	1	4	1	14
<i>Five Years</i>								
Balanced	-	-	2(100)	1(100)	-	-	-	3(50)
Overpopulated Bg.	-	-	-	-	1(50)	-	-	1(17)
Overpopulated Bass	-	1(100)	-	-	1(50)	-	-	2(33)
TOTALS	-	1	2	1	2	-	-	6

The success of the different rates for the 1954 series is shown in Table IX. The rates of 80:500 and 100:70 were the most successful in this series, however, the number of ponds included in this analysis is admittedly small.

TABLE IX
SUCCESS OF RATES FOR THE 1954 SERIES IN MANAGEABLE AND MARGINAL PONDS
(COMBINED) ONE, TWO AND THREE YEARS AFTER STOCKING
(The Figure in Parenthesis Represents Percent [%])

Status	One Year							Totals
	Fry Bass:Fingerling Bluegill				Fry Bass:Adult Bluegill			
	30:400	50:500	80:500	100:500	100:30	100:50	100:70	
Balanced	2(25)	2(100)	4(100)	3(75)	2(50)	2(40)	5(56)	20(55)
Overpopulated Blg.	6(75)	—	—	1(25)	2(50)	1(20)	4(44)	14(39)
Overpopulated Bass	—	—	—	—	—	2(40)	—	2(6)
TOTALS	8	2	4	4	4	5	9	36
Status	Two Years							Totals
	Fry Bass:Fingerling Bluegill				Fry Bass:Adult Bluegill			
	30:400	50:500	80:500	100:500	100:30	100:50	100:70	
Balanced	3(50)	1(50)	5(83)	2(50)	2(67)	2(40)	7(78)	22(63)
Overpopulated Blg.	3(50)	—	1(17)	1(25)	—	1(20)	2(22)	8(23)
Overpopulated Bass	—	1(50)	—	1(25)	1(33)	2(40)	—	5(14)
TOTALS	6	2	6	4	3	5	9	35
Status	Three Years							Totals
	Fry Bass:Fingerling Bluegill				Fry Bass:Adult Bluegill			
	30:400	50:500	80:500	100:500	100:30	100:50	100:70	
Balanced	3(75)	1(50)	2(40)	1(20)	3(50)	1(33)	3(33)	14(41)
Overpopulated Blg.	1(25)	—	1(20)	3(60)	—	2(67)	4(44)	11(32)
Overpopulated Bass	—	1(50)	2(40)	1(20)	3(50)	—	2(22)	9(27)
TOTALS	4	2	5	5	6	3	9	34

The success of rates in the 1955 series is shown in Table X. In this series there appears to be little difference in the degree of success of 80:500, 100:500, 100:30, 100:50, and 100:70. A comparison of the success of rates in manageable and marginal ponds is shown in Table XI.

TABLE X
SUCCESS OF RATES FOR THE 1955 SERIES IN MANAGEABLE AND MARGINAL PONDS
(COMBINED) ONE AND TWO YEARS AFTER STOCKING
(The Figure in Parenthesis Represents Percent [%])

Status	One Year							Totals
	Fry Bass:Fingerling Bluegill				Fry Bass:Adult Bluegill			
	30:400	50:500	80:500	100:500	100:30	100:50	100:70	
Balanced	4(29)	5(33)	6(40)	4(27)	6(55)	15(71)	5(62)	45(46)
Overpopulated Blg.	10(71)	10(67)	7(47)	7(47)	2(18)	6(29)	2(25)	44(44)
Overpopulated Bass	—	—	2(13)	4(27)	3(27)	—	1(12)	10(10)
TOTALS	14	15	15	15	11	21	8	99
Status	Two Years							Totals
	Fry Bass:Fingerling Bluegill				Fry Bass:Adult Bluegill			
	30:400	50:500	80:500	100:500	100:30	100:50	100:70	
Balanced	3(27)	5(31)	10(67)	11(65)	5(56)	11(52)	5(50)	50(51)
Overpopulated Blg.	8(73)	8(50)	4(27)	5(29)	3(33)	7(33)	4(40)	39(39)
Overpopulated Bass	—	3(19)	1(7)	1(6)	1(11)	3(14)	1(10)	10(10)
TOTALS	11	16	15	17	9	21	10	99

TABLE XI
SUCCESS OF RATES FOR THE 1955 SERIES IN MANAGEABLE AND MARGINAL PONDS
ONE AND TWO YEARS AFTER STOCKING
(The Figure in Parenthesis Represents Percent [%])

Status	<i>One Year, Manageable Ponds</i>							
	<i>Fry Bass:Fingerling Bluegill</i>				<i>Fry Bass:Adult Bluegill</i>			
	30:400	50:500	80:500	100:500	100:30	100:50	100:70	Totals
Balanced	2(22)	4(67)	4(50)	3(33)	5(62)	10(83)	4(67)	32(55)
Overpopulated Blg.	7(78)	2(33)	4(50)	3(33)	1(12)	2(17)	2(33)	21(36)
Overpopulated Bass	—	—	—	3(33)	2(25)	—	—	5(9)
TOTALS	9	6	8	9	8	12	6	58
Status	<i>Two Years, Manageable Ponds</i>							
	30:400	50:500	80:500	100:500	100:30	100:50	100:70	Totals
	Balanced	2(50)	2(40)	7(64)	7(70)	4(57)	10(67)	3(50)
Overpopulated Blg.	2(50)	1(20)	4(36)	3(30)	2(29)	4(27)	3(50)	19(33)
Overpopulated Bass	—	2(40)	—	—	1(14)	1(7)	—	4(7)
TOTALS	4	5	11	10	7	15	6	58
Status	<i>One Year, Marginal Ponds</i>							
	30:400	50:500	80:500	100:500	100:30	100:50	100:70	Totals
	Balanced	2(40)	1(11)	2(29)	1(17)	1(33)	5(56)	1(50)
Overpopulated Blg.	3(60)	8(89)	3(43)	4(67)	1(33)	4(44)	—	23(56)
Overpopulated Bass	—	—	2(29)	1(17)	1(33)	—	1(50)	5(12)
TOTALS	5	9	7	6	3	9	2	41
Status	<i>Two Years, Marginal Ponds</i>							
	30:400	50:500	80:500	100:500	100:30	100:50	100:70	Totals
	Balanced	1(14)	3(27)	3(75)	4(57)	1(50)	1(17)	2(50)
Overpopulated Blg.	6(86)	7(64)	—	2(29)	1(50)	3(50)	1(25)	20(49)
Overpopulated Bass	—	1(9)	1(25)	1(14)	—	2(33)	1(25)	6(15)
TOTALS	7	11	4	7	2	6	4	41

Table XII shows the success in each soils region for the first three years. All four series are combined in this table. It is regrettable that there were not enough ponds in each soils region to determine individual rate success for that region.

The status of the ponds stocked with the various rates is shown in Table XIII.

TABLE XII
STATUS OF PONDS IN EACH SOILS REGION FOR ALL SERIES MANAGEABLE AND MARGINAL PONDS (COMBINED) ONE, TWO AND THREE YEARS AFTER STOCKING
(The Figure in Parenthesis Represents Percent [%])

Status	<i>One Year</i>							Totals	
	Outer Bluegrass	Inner Bluegrass	Eastern Coalfields	Western Coalfields	Penny-royal	Jackson Purchase			
Balanced	8(36)	3(75)	14(61)	6(55)	13(59)	3(60)	47(54)		
Overpopulated Blg.	11(50)	1(25)	2(9)	4(36)	7(32)	1(20)	26(30)		
Overpopulated Bass	3(14)	—	7(30)	1(9)	2(9)	1(20)	14(16)		
TOTALS	22	4	23	11	22	5	87		
Status	<i>Two Years</i>							Totals	
	Balanced	13(50)	3(30)	19(68)	11(79)	15(62)	2(50)		63(59)
	Overpopulated Blg.	13(50)	7(70)	4(14)	2(14)	5(21)	—		31(29)
Overpopulated Bass	—	—	5(18)	1(7)	4(17)	2(50)	12(11)		
TOTALS	26	10	28	14	24	4	106		
Status	<i>Three Years</i>							Totals	
	Balanced	5(45)	—	6(43)	7(87)	2(50)	2(100)		22(54)
	Overpopulated Blg.	4(36)	2(100)	3(21)	—	1(25)	—		10(24)
Overpopulated Bass	2(18)	—	5(36)	1(12)	1(25)	—	9(22)		
TOTALS	11	2	14	8	4	2	41		

TABLE XIII
 STATUS OF PONDS STOCKED WITH FRY BASS-FINGERLING BLUEGILL RATES OF
 30:400, 50:500 AND 100:500 AND FRY BASS-ADULT BLUEGILL RATES
 OF 100:30, 100:50 AND 100:70, PER SURFACE ACRE AFTER
 ONE, TWO AND THREE YEARS

Status	1952 Series					1953 Series					1954 Series					Totals						
	30:400	50:500	80:500	100:500	100:30	100:50	100:70	30:400	50:500	80:500	100:500	100:30	100:50	100:70	30:400	50:500	80:500	100:500	100:30	100:50	100:70	
Balanced	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	4
Overpop. Bfg.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Overpop. Bass	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	7
Total	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	11
Balanced	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Overpop. Bfg.	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
Overpop. Bass	0	3	3	3	2	3	2	3	1	2	3	4	3	1	5	4	5	4	5	4	1	21
Total	1	6	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	26
Balanced	-	2	2	-	-	-	-	2	1	3	2	-	2	4	2	2	4	2	4	3	2	9
Overpop. Bfg.	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Overpop. Bass	-	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	7
Total	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	11
Balanced	-	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Overpop. Bfg.	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Overpop. Bass	1	2	4	3	2	3	4	4	1	1	1	1	1	1	1	1	1	1	1	1	1	11
Total	2	3	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	22
Balanced	-	-	-	-	-	-	-	3	1	1	1	1	1	1	1	1	1	1	1	1	1	3
Overpop. Bfg.	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Overpop. Bass	-	2	3	3	2	3	4	4	1	1	1	1	1	1	1	1	1	1	1	1	1	11
Total	1	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	14
Balanced	-	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Overpop. Bfg.	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Overpop. Bass	1	2	4	3	2	3	4	4	1	1	1	1	1	1	1	1	1	1	1	1	1	11
Total	2	3	6	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	22
Balanced	-	-	-	-	-	-	-	3	1	1	1	1	1	1	1	1	1	1	1	1	1	3
Overpop. Bfg.	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Overpop. Bass	-	2	3	3	2	3	4	4	1	1	1	1	1	1	1	1	1	1	1	1	1	11
Total	1	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	14
Balanced	-	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Overpop. Bfg.	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Overpop. Bass	1	2	4	3	2	3	4	4	1	1	1	1	1	1	1	1	1	1	1	1	1	11
Total	2	3	6	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	22
Balanced	-	-	-	-	-	-	-	3	1	1	1	1	1	1	1	1	1	1	1	1	1	3
Overpop. Bfg.	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Overpop. Bass	-	2	3	3	2	3	4	4	1	1	1	1	1	1	1	1	1	1	1	1	1	11
Total	1	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	14

One Year
 Two Years
 Three Years

Although the above tables depict certain rates to be more successful than others, the author believes that because of the differences in watersheds and immediate environment, the differences in percentages of success among the following rates, 80:500, 100:500, 100:30, 100:50, and 100:70, is not great enough to justify any major changes in stocking policies of this state, based only on the above data.

Other Influencing Factors

As is shown in Figure 2, data concerning water transparency, aquatic weeds, fishing pressure, etc., was collected during the investigations. Although it was not possible to correlate any of these factors with the success of the various rates, many are worth examining.

No correlation could be found between the size of the bluegill stocked and the amount of bluegill spawn in the first year. In some instances, bluegill stocked as fingerlings produced as much or more spawn as bluegill stocked as adults produced in comparable ponds. At other times fish stocked as adults produced more spawn than fingerling stocked fish. From observation it appeared that the amount of spawn produced probably depended more on the environment than it did on the size of the bluegills that were stocked. It was also found that bluegill stocked as fingerlings reproduced at approximately the same time during the first year as the adult stocked fish.

In many ponds the bass did not always reproduce after 1 year's growth, but stocking rates seemed to have little effect. If the pond was fertile and clear and the bluegills did not become overpopulated during the first summer, the stocked bass usually reproduced after 1 year's growth.

Very little data were collected concerning the percentage of harvestable fish in balanced and unbalanced ponds. It was planned to drain or pump dry a series of ponds for this purpose in 1953 and 1954, but due to the drought the pond owners needed all available water. Also the cost of renting equipment to pump dry the ponds that could not be drained was prohibitive, therefore, this phase of the project was discontinued in late 1953.

A total of 4 ponds were drained, however, in the fall and winter of 1953. The 4 ponds were stocked on 2 adult rates, 100 fry bass to 30 adult bluegill, and 100 fry bass to 40 adult bluegill, and 2 fingerling rates, 100 fry bass to 1,000 fingerling bluegill and 135 fry bass to 134 fingerling bluegill. The analysis of the population from these 4 ponds is shown in Table XIV. In this study, harvestable fish included bass 8 inches or more in length and bluegill 5 or more inches long. The percentages of harvestable fish from the adult stocked ponds were 13.3 and 7.3 and percentage of harvestable fish from the fingerling stocked ponds amounted to 58.3 and 48.9.

During the annual investigations the amount of aquatic vegetation for each pond was recorded. Although no correlation between balance and weed growth was found, the data did point out the fact that bass invariably reproduced in ponds with dense growths of pond weed, *Potamogeton sp.*, regardless of the numbers of bluegill present.

Water level fluctuation was found to be a problem in many ponds. In some areas, ponds got very low each summer and overflowed freely in the winter and spring. In most cases the investigators were able to get this information from the owners, but in some instances ponds probably overflowed about which nothing was known. Some of the ponds that overflowed freely were found to be overpopulated with bluegill during one investigation and were found to be balanced the following year. Undoubtedly many fish and nutrients were lost over the spillway.

Very little correlation was found between balance and fishing pressure. Very few owners fished or let the public fish their ponds heavily and some allowed no fishing. The only real problem created by fishing was that some owners caught most of the bass in their pond before they had spawned for the first time.

Many owners were dissatisfied with shellcracker because they did not bite as readily as bluegill. Some of this dissatisfaction may be dispelled as they learn more about angling for these fish.

TABLE XIV
ANALYSIS OF DATA FROM PONDS DRAINED IN 1953

	<i>Pond A</i>	<i>Pond B</i>	<i>Pond C*</i>	<i>Pond D</i>
Location	P	O. B.	P	E. C.
Rate	100:30	100:40	100:1000	134:134
Size (Acres)	1.08	1.00	0.27	0.30
<i>Bass:</i>				
Number Stocked	101	100	27	40
Size of Fish	1½"	2"	1½"	1"
Date Stocked	6-22-53	6-25-53	6-19-53	5-21-53
<i>Bluegill:</i>				
Number Stocked	33	40	270	40
Size of Fish	6"	5"-6"	3"	3"
Date Stocked	4-23-53	4-15-53	4-24-53	3-13-53
Date Drained	11-18-53	11-12-53	12-3-53	12-12-53
<i>Bass:</i>				
Number Recovered **	95	46	24	23
Percent of Recovery	94%	46%	89%	58%
Weight Per Acre	18.8	9.5	31.1	15.1
<i>Bluegill:</i>				
Number Recovered **	20	23	154	23
Percent of Recovery	61%	58%	57%	58%
Weight Per Acre	20.2	118.1	122.3	14.5
Total Weight Per Acre	39.0	127.6	153.4	29.6
Percent of Harvestable Fish	13.3%	7.3%	58.3%	48.9%

* This pond was fertilized.

** Fish that were stocked initially

Discontinuance of Ponds

After investigations had begun in 1953, it was evident that nothing of value could be gained by keeping certain ponds on an experimental basis. In 1954, it was decided to discontinue studying any pond from which reliable data could not be procured. Ponds were discontinued because of the following reasons:

1. Other Fish: Included any fish that was not stocked experimentally. It was not always possible to tell which fish were stocked and which gained access by other means.
2. Dry or Very Low: Includes ponds that went completely dry or became low enough that fish survival was in doubt.
3. Errors in Stocking: Many ponds were found to be smaller than originally reported. This pertains mostly to the 1952 series where the applications were pulled directly from the departmental files and the ponds were not investigated by project personnel. In one or two cases the owner had two ponds or more and the wrong pond was stocked.
4. No Population: A few ponds had fish kills from oxygen depletion, or the population was depleted because of crop spraying, or because of organic pollution from septic tanks.
5. Renovated: The owners became dissatisfied and wanted the population removed.
6. Physically Unsited: Many ponds were lost due to heavy silting or by livestock trampling the banks and dam. A few owners placed barbed wire or trees in their ponds to keep out poachers and thus made seining difficult. In some ponds weeds became such a problem that seining was prohibited.
7. Rates Discontinued: A few ponds were stocked with rates other than the original series. These were later discontinued at the suggestion of the U. S. Fish and Wildlife Service.
8. Inaccessible: The investigators were unable to check a number of ponds because of the impassability of roads or because of the erection of barriers, such as, fences or crops by the owners.

The number of ponds that were discontinued each year from 1954 through 1957 is shown in Table XV. A total of 326 or 64.3% of the total number stocked were discontinued. The invasion of the ponds by other fish was the principal reason that ponds were discontinued during this investigation. The effects of the drought is reflected in the number of dry ponds which was second on the list of reasons for pond discontinuance.

TABLE XV
 BASS-BLUEGILL PONDS DISCONTINUED FROM 1954 THROUGH 1957

Reasons for Discontinuance	1952 Series					1953 Series					1954 Series					1955 Series												
	Year Discontinued					Year Discontinued					Year Discontinued					Year Discontinued												
	1954	1955	1956	1957	Total	1954	1955	1956	1957	Total	1954	1955	1956	1957	Total	1955	1956	1957	Total	% of Number Stocked	% of Number Stocked	% of Number Stocked	% of Number Stocked	Total	Total	Total	Total	
Other Fish	4	-	-	-	16	17.9	17	2	-	1	20	20.4	13	5	3	-	21	21.0	47	9	3	49	26.0	116	22.5	116	22.5	
Dry or Low	13	1	1	-	15	16.9	16	-	2	-	18	18.4	11	3	2	-	16	16.0	29	3	1	33	14.5	82	16.0	82	16.0	
Physically Unsuitable...	13	2	-	-	15	16.9	3	3	1	-	7	7.1	3	9	1	-	13	13.0	6	1	2	9	4.0	44	8.6	44	8.6	
Errors in Stocking ..	10	4	-	-	14	15.7	5	8	1	-	14	14.3	1	2	1	-	4	4.0	5	-	-	5	2.2	37	7.2	37	7.2	
Rates Discontinued ..	1	-	-	-	1	1.1	6	2	-	-	8	8.2	-	-	-	-	0	0	-	-	-	0	0	0	9	1.8	9	1.8
No Population	1	-	-	-	1	1.1	3	2	1	-	6	6.1	2	-	-	-	2	2.0	1	2	-	3	1.3	12	2.3	12	2.3	
Renovated	1	-	3	-	4	4.5	1	-	1	-	2	2.0	1	-	1	3	5	5.0	-	-	4	4	1.8	15	2.9	15	2.9	
Inaccessible	9	-	-	-	9	10.1	1	-	-	-	1	1.0	-	-	1	-	1	1.0	-	-	-	0	0	11	2.1	11	2.1	
Total Discontinued ...	60	11	4	0	75	84.3	52	17	6	1	77	78.6	31	19	9	3	62	62.0	88	15	10	113	49.8	326	63.4	326	63.4	
Number Stocked					89						98						100					227				514		

The number of ponds that were discontinued in each soils region is shown in Table XVI. In the Bluegrass region of the state the most serious problem was other fish entering the pond. In the Pennyroyal the most serious problems encountered were the inability of ponds to hold water and the heavy siltation. Better cover crops and less cultivation would prevent much of the situation.

TABLE XVI
BASS-BLUEGILL PONDS DISCONTINUED FROM 1954 THROUGH 1957,
ALL SERIES COMBINED, FOR EACH SOILS REGION

Reasons for Discontinuance	Outer Bluegrass		Inner Bluegrass		Eastern Coalfields		Western Coalfields		Pennyroyal	Jackson Purchase		Totals	Percent of Number Stocked	
	Number	Percent of Number Stocked	Number	Percent of Number Stocked	Number	Percent of Number Stocked	Number	Percent of Number Stocked		Number	Percent of Number Stocked			
Other Fish	56	29.9	13	27.1	22	21.5	7	14.6	29	25.6	2	12.4	129	25.1
Dry or Low	33	17.6	6	12.5	13	12.7	5	10.4	24	21.2	1	6.2	82	16.0
Errors in Stocking 13	7.0	4	8.3	7	6.9	4	8.3	9	8.0	-	-	37	7.2	
No Population	6	3.2	1	2.1	1	1.0	-	-	4	3.5	-	-	12	2.3
Renovated	4	2.1	3	6.2	3	2.9	1	2.1	4	3.5	-	-	15	2.9
Physically Unsuitable 10	5.3	8	16.7	6	5.9	3	6.2	15	13.3	2	12.5	44	8.6	
Rates Discontinued 1	0.5	-	-	4	3.9	1	2.1	2	1.8	1	6.2	9	1.8	
Inaccessible	4	2.1	1	2.1	4	3.9	1	2.1	-	-	1	6.2	11	2.1
Total Discontinued 128	68.3	37	77.1	51	50.0	25	52.1	74	65.5	11	68.8	326	63.4	
Total Stocked	187		48		102		48		113		16		514	

BASS-SHELLCRACKER INVESTIGATIONS

Rate Distribution of Bass-Shellcracker Ponds

A total of 89 ponds were stocked with bass-shellcracker combinations in 1953, 1955, and 1956. Only 5 ponds were stocked in 1953 and these failed to yield any reliable data. They were discontinued after the 1955 field investigation. The distribution of the remaining 84 ponds is shown in Table XVII.

TABLE XVII
DISTRIBUTION OF BASS-SHELLCRACKER PONDS

Soils Region	Series	50:300	50:600	50:300:400	50:600:400	Totals
Outer	55	8	8	3	3	22
Bluegrass	56	4	4	3	4	15
Inner	-	-	-	1	1	2
Bluegrass	56	1	1	1	1	4
Eastern	55	-	-	1	-	1
Coalfields	56	-	-	-	-	0
Western	55	3	3	2	2	10
Coalfields	56	-	-	-	-	0
Pennyroyal	55	7	6	3	4	20
royal	56	-	-	-	-	0
Jackson	55	4	3	1	2	10
Purchase	56	-	-	-	-	0
TOTALS		27	25	15	17	84

History of the 1955 Series

When the ponds for the 1955 bass-bluegill series were selected in the fall of 1954, many marginal ponds were selected for the 1955 bass-shellcracker series. Approximately 75% of these were old marginal ponds that had been rotenoned and were ready for restocking. The other 25% were new, manageable ponds that were stocked with shellcracker at the request of the owners.

A total of 65 ponds were stocked in this series, Table XVIII. All of the ponds were stocked with shellcracker in the fall and winter of 1954. In a few cases the ponds were frozen over and the fish were stocked through a hole in the ice. It is known that the shellcrackers did not survive in 3 ponds that were stocked in this manner.

TABLE XVIII
HISTORY OF THE 1955 SERIES
(The Figure in Parenthesis Represents Percent [%])

<i>Status</i>	<i>Status in 1956, 65 Ponds</i>			<i>Totals</i>
	<i>Manageable</i>	<i>Marginal</i>	<i>Unclassified</i>	
Balanced	2 (29)	4 (44)	1 (100)	7 (41)
Overpopulated Shellcracker	-	1 (11)	-	1 (6)
Overpopulated Bass	5 (71)	4 (44)	-	9 (53)
Not Checked	-	-	1	1
Undetermined	-	-	6	6
Discontinued	-	-	41	41
TOTALS	7	9	49	65

<i>Status</i>	<i>Status in 1957, 24 Ponds</i>			<i>Totals</i>
	<i>Manageable</i>	<i>Marginal</i>	<i>Unclassified</i>	
Balanced	6 (50)	2 (22)	-	8 (38)
Overpopulated Shellcracker	-	2 (22)	-	2 (10)
Overpopulated Bass	6 (50)	5 (56)	-	11 (52)
Undetermined	-	-	1	1
Discontinued	-	-	2	2
TOTALS	12	9	3	24

History of the 1956 Series

In the 1956 series ponds were selected from the Bluegrass region of the state only. Six old ponds, 2 of which were marginal and 4 manageable, and 13 new ponds, of which 9 were manageable and 4 were marginal were selected for this series. All were stocked in the fall of 1955. A history of this series is shown in Table XIX.

TABLE XIX
HISTORY OF THE 1956 SERIES
(The Figure in Parenthesis Represents Percent [%])

<i>Status</i>	<i>Status in 1957, 19 Ponds</i>			<i>Totals</i>
	<i>Manageable</i>	<i>Marginal</i>	<i>Unclassified</i>	
Balanced	1 (50)	-	-	1 (25)
Overpopulated Shellcracker	1 (50)	-	-	1 (25)
Overpopulated Bass	-	-	2 (100)	2 (50)
Undetermined	-	-	2	2
Discontinued	-	-	13	13
TOTALS	2	-	17	19

Success of Rates

The success of the 4 rates in manageable and marginal ponds for the 1955 series is shown in Tables XX and XXI. There are not enough ponds represented here to determine which rate was the more successful, but this table does reveal that shellcracker do not provide enough forage for bass. Bass

became overpopulated in a large percentage of both manageable and marginal ponds.

Very few ponds became overpopulated with shellcrackers. In manageable ponds there were no ponds overpopulated, and in marginal ponds less than 25% became overpopulated with this species.

TABLE XX
SUCCESS OF RATES FOR THE 1955 BASS-SHELLCRACKER SERIES IN MANAGEABLE AND MARGINAL PONDS ONE AND TWO YEARS AFTER STOCKING
(The Figure in Parenthesis Represents Percent [%])

Status	One Year, Manageable Ponds				Totals
	Fry Bass 50:300	Fing. Shc. 50:600	Fry Bass:Fing. Shc. & Gambusia 50:300:400 50:600:400		
Balanced	-	2 (50)	-	-	2 (29)
Overpopulated Shellc.	-	-	-	-	0
Overpopulated Bass	2 (100)	2 (50)	-	1 (100)	5 (71)
TOTALS	2	4	0	1	7
	Two Years, Manageable Ponds				
Balanced	2 (67)	4 (67)	-	-	6 (50)
Overpopulated Shellc.	-	-	-	-	0
Overpopulated Bass	1 (33)	2 (33)	1 (100)	2 (100)	6 (50)
TOTALS	3	6	1	2	12
	One Year, Marginal Ponds				
Balanced	3 (75)	-	-	1 (50)	4 (44)
Overpopulated Shellc.	-	1 (33)	-	-	1 (11)
Overpopulated Bass	1 (25)	2 (67)	-	1 (50)	4 (44)
TOTALS	4	3	0	2	9
	Two Years, Marginal Ponds				
Balanced	-	-	1 (100)	1 (50)	2 (22)
Overpopulated Shellc.	1 (33)	1 (33)	-	-	2 (22)
Overpopulated Bass	2 (67)	2 (67)	-	1 (50)	5 (56)
TOTALS	3	3	1	2	9

TABLE XXI
SUCCESS OF RATES FOR THE 1955 BASS-SHELLCRACKER SERIES IN MANAGEABLE AND MARGINAL PONDS (COMBINED) ONE AND TWO YEARS AFTER STOCKING
(The Figure in Parenthesis Represents Percent [%])

Status	One Year				Totals
	Fry Bass 50:300	Fing. Shc. 50:600	Fry Bass:Fing. Shc. & Gambusia 50:300:400 50:600:400		
Balanced	3 (50)	2 (29)	-	1 (33)	6 (38)
Overpopulated Shellc.	-	1 (14)	-	-	1 (6)
Overpopulated Bass	3 (50)	4 (57)	-	2 (67)	9 (56)
TOTALS	6	7	-	3	16
	Two Years				
Balanced	2 (33)	4 (44)	1 (50)	1 (25)	8 (38)
Overpopulated Shellc.	1 (17)	1 (11)	-	-	2 (10)
Overpopulated Bass	3 (50)	4 (44)	1 (50)	3 (75)	11 (52)
TOTALS	6	9	2	4	21

In some of the ponds stocked with *Gambusia* and shellcrackers, the bass grew very fast and were in excellent condition at the end of the first year. These bass produced very heavy spawns which failed to maintain this good growth because most of the *Gambusia* had disappeared and the shellcrackers failed to produce the required amount of forage.

Discontinuance of Ponds

Ponds were discontinued from the bass-shellcracker series for many of the same reasons that the bass-bluegill ponds were discontinued, Table XXII.

TABLE XXII
BASS-SHELLCRACKER PONDS DISCONTINUED FROM 1955 THROUGH 1957
(COMBINED)

Reason for Discontinuance	1955 Series	% of No. Stocked	1956 Series	% of No. Stocked	Totals	% of T.N. Stocked
Other Fish	37	57.0	14	73.1	51	60.7
Dry or Very Low	1	1.5	-	--	1	1.2
Errors in Stocking	1	1.5	1	5.3	2	2.4
Physically Unsuitable	3	4.6	-	--	3	3.6
No Population	1	1.5	-	--	1	1.2
Total Discontinued	43	66.2	15	78.9	58	69.0
Total Stocked	65		19		84	

The addition of other fish was the principal reason that ponds were discontinued. Many of the ponds in the 1955 and 1956 series were old ponds that had been treated with rotenone to eliminate the populations. A complete kill was not effected in many of these ponds. Wet seasons prevailed during the years 1955 and 1956, and for that reason only 1 pond went dry in the two series.

DISCUSSION

It is unfortunate that so many rates were selected for this study. Table VI shows that only 168 of the 514 ponds stocked with bass-bluegill combinations produced comparable data. Twenty-four ponds for each of the seven rates tested might have been an adequate sample, however, these rates were stocked in ponds which were located in six different soils regions, distributed throughout the state. This represents 4 ponds for each rate per soils region. Discontinuance of ponds did not result in equal distribution among the seven rates, therefore, some regions were left without representation for some rates.

Individual ponds were not always representative of the average pond in the soils region in which they were located. Actually, some ponds located in one soil region were more typical of ponds in other regions. This was especially true along the border of the regions since the change of soil types from one region to another is not abrupt but very gradual. In many of the so-called infertile areas progressive farmers had improved their land to such an extent that their ponds were more fertile than some ponds in the most fertile areas of the state.

It was planned to stock the experimental ponds at the same time that ponds were being stocked on the regular state-wide stocking program, but this was not possible. Vehicles and personnel were not available. As a result most of the experimental stocking was delayed until after the regular deliveries had been made. This most seriously affected the shellcrackers that were stocked in 1955, because some of them had to be stocked in sub-freezing temperatures. It is known that shellcrackers did not survive in 3 ponds stocked at this time and undoubtedly many more perished in other ponds.

Another stocking problem was the presence of bluegill, and sometimes green sunfish, in some of the shellcracker brood ponds in the hatcheries. It was almost impossible to separate these fishes completely due to the time involved.

Many owners did not want their ponds stocked with rates that had few bass. It was found that many times the owners stocked additional bass in ponds so

stocked. In other instances, owners were reluctant to cooperate after their ponds had been stocked on rates that had few bass.

Many problems encountered during these investigations were due to the differences in soils regions. In the Eastern Coalfields region a large majority of the ponds have little shallow area for bluegill spawning grounds. Bass are able to spawn readily in the deeper waters and many ponds in this region tend to become overpopulated with bass, due to the lack of forage. It is suggested that ponds in this region be so constructed that adequate spawning areas will be present after impoundment. Fertilization would help to provide increased production of forage.

In other areas of the state, especially in the Bluegrass region, a large majority of the ponds have too much shallow area. The bluegill in ponds in these areas spawn too successfully and the ponds tend to become overpopulated with bluegills. To alleviate this overproduction of forage and subsequent overpopulation of bluegill was the primary reason that the bass-shellcracker rates were investigated. The results of these studies were inconclusive, however, and more investigation of these combinations are needed. It is suggested that at the present time, ponds in the Bluegrass region be stocked with adequate numbers of bass to help keep the heavy forage population under control. In the construction of new ponds, extensive shallow areas should be avoided.

It is regrettable that so many ponds had to be discontinued during this investigation. However, much information was obtained about what factors need to be taken into account in planning a study of this type or in establishing stocking policies.

Many owners added 3 or 4 adult bass or adult bluegill to their ponds, since they had little or no idea of the reproductive potential of these fish. They couldn't understand why adding just 3 or 4 fish would make any difference. Although the investigators did explain to the owner when the ponds were selected that it was imperative that the ponds be devoid of fish life when they were stocked experimentally, this point wasn't stressed sufficiently, nor fully explained. It would probably have been profitable to take a little time and explain to the owners why 3 or 4 additional fish did ruin the experiment.

The sizes of the ponds, as reported by conservation officers, were sometimes as much as 100% wrong. It will do little good to establish specific rates for certain areas if this deplorable, inaccurate reporting continues.

It was found during the first phase of the study that ponds less than $\frac{1}{2}$ acre seldom produced balanced populations. It would seem advisable that some restriction be placed on the size of ponds to be stocked and especially on ponds to be renovated by state personnel. This should encourage the building of larger and better constructed ponds.

Other fish entering the ponds from the drainage areas was the cause of many ponds being discontinued during the study. This could have been alleviated, somewhat, if the areas above and below the ponds had been investigated fully, but the investigators did not have time to do this. It was suggested that each pond be rotenoned in the fall, prior to stocking the following spring, but this would not have helped because over 95% of the ponds used in this investigation were new ponds that were built in the summer preceding stocking. Therefore, they did not fill with water until late fall and winter. It appears that most of the fish that entered did so in the winter and early spring when there is an abundance of rainfall. It might have helped to rotenone the ponds about 1 month before stocking, but this would have been difficult because of the heavy rains at this time of year. A barrier would have prevented the invasion of other fish from below the spillway in many cases.

Another factor causing the discontinuance of many ponds was the use of these ponds by livestock. Since most of the farm ponds in this state are constructed for the purpose of providing water for livestock and irrigation and not for fish production, very few are fenced. In this investigation a great many ponds, which were manageable when they were selected, became marginal or completely unmanageable, because of the presence of large numbers of livestock roiling the water and trampling the banks during the summer. The investigators always inquired as to what extent livestock would use the ponds, and if the expected use of the ponds by livestock was considered excessive, the pond was rejected.

But this could not always be foreseen by the owners. This was especially true in 1953 and 1954 when many streams dried up and the livestock had to water out of ponds.

As had been mentioned before the largest percentage of ponds in this investigation were new ponds. It would have been difficult to get ponds for experimental purposes if new ponds hadn't been selected, because most of the owners wanted their ponds stocked immediately after filling. It was advantageous to select new ponds because they supposedly did not have fish populations, but there were also disadvantages in using this type of pond. It was not always possible to tell if the ponds were going to hold water and as a result there was a large number of ponds that went dry. Some of the ponds were very infertile the first year after impoundment and would not support a representative fish population.

CONCLUSIONS AND RECOMMENDATIONS

In these investigations the most successful rates for all types of ponds were 100 fry bass to 50 adult bluegill and 80 fry bass to 500 fingerling bluegill per acre. Although these rates were found to have the highest percentage of success, it is believed that the difference in percentage of success among any of the following rates 80:500, 100:500, 100:30, and 100:70 is not great enough to justify any major change in stocking policy based only on this data above. It is recommended that a rate be selected that provides for the fisherman the greatest percentage of harvestable fish. The very limited amount of research done on this subject during these investigations indicates that fingerling stocked ponds produce the highest percentage of harvestable fish. More investigation is needed however, to determine what combinations are best suited for this purpose.

In the Eastern Coalfields region ponds tend to become overpopulated with bass due to the lack of forage which in turn is due to the lack of suitable spawning areas. Fertilization would greatly aid fish production in terms of pounds of fish in many ponds in this region, and should aid in the production of sufficient forage for bass also.

In the Bluegrass regions there is a tendency for ponds to become overpopulated with bluegill because in most ponds bluegill spawning areas are too extensive. New stocking rates that provide enough bass (a minimum of 100 per acre) to control this heavy forage population is recommended.

Other fish entering ponds is also a serious problem. In many ponds barriers would prevent the invasion of other fish.

During the selection of ponds by project personnel it was found that in many cases the size of the ponds, as reported on the stocking application, was incorrect, sometimes as much as 100%. Undoubtedly some of this error was due to ponds not being measured. Results of earlier investigations demonstrated that ponds below $\frac{1}{2}$ acre in size seldom produced balanced populations. It is therefore recommended that no ponds be stocked or renovated by state personnel that are less than $\frac{1}{2}$ acre in size, except in unusual cases, such as, properly fertilized ponds, or ponds that were constructed primarily for fishing. This would not only put the state-wide farm pond program on a sound biological and economical basis, but would save time for the man in the field, who inspects ponds to be stocked, since he would not have to measure ponds that were plainly evident to be less than $\frac{1}{2}$ acre in size.

It was found that many potentially good fish ponds were ruined because large numbers of livestock were allowed free access to all parts of the pond. Owners should be encouraged to fence their ponds and to provide limited watering areas or to provide watering troughs below the dam. This would eliminate trampled fish nests, roiled water, decreased food production, and eroding banks and quite possibly prolong the life of the pond.

Results of this investigation reveal that in new ponds the stocked bass failed to reach spawning size in 1 year. Many populations are undoubtedly thrown out of balance because of the removal of the bass, by angling, before the first bass spawn. It is therefore recommended that in new ponds the owner be instructed to refrain from fishing for bass for 2 years from the time the bass are stocked, unless they are absolutely certain the bass have spawned.

There are indications that shellcrackers do not provide enough forage to promote good bass growth in manageable ponds. However, it was also noted that very few ponds stocked with bass-shellcracker combinations became overpopulated with shellcrackers. Since the overpopulation by the forage species seems to be the number one problem in shallow ponds, bass-shellcracker combinations may be the answer in this type of pond. This is definitely worthy of more investigation.

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HISTORY OF FISH AND FISHING IN NORRIS A TVA TRIBUTARY RESERVOIR

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ABSTRACT

Norris Reservoir, the first TVA tributary reservoir, completed in 1936, has a spillway surface area of 34,200 acres. Earliest fish inventory records in the basin indicate 17 indigenous families of fishes represented by 40 genera and 65 species. Four families, Petromyzonidae, Anguillidae, Cyprinodontidae, and Cottidae, were unable to cope with the reservoir environment. Several genera and species of Cyprinidae and Percidae likewise did not survive. Game and commercial species generally have prospered in the reservoir.

A 14-year creel census on Norris shows considerable annual variation in catch but no trend to support the historical idea that reservoirs become "biological deserts."

Harvesting or fishing mortality studies over a 14-year period show an average tag return ratio of 17.2 percent. Year to year variation from the mean indicates that the obvious increase in fishing pressure since 1940 has not increased the relative rate of harvest. Variation in harvest rate by species is also shown. The Norris data show that the offer of prizes has little influence on tag returns.

Redistribution of species within a reservoir is also indicated by tag returns. Sauger and walleye in Norris travelled 0-150 miles, black basses and crappie 0 to 35 miles.

INTRODUCTION

Fisheries problems in the impounded waters of California, the Southeastern states, and in the large impoundments of the Missouri River were discussed at length in 1957 by Kimsey, Parsons, and Shields, respectively.

According to Parsons, reservoir surface area in the Southeast totals 2,009,000 acres (spillway levels). Of this total the TVA system accounts for 600,000 acres, or about 30 percent.

In approaching the history of fish and fishing in TVA reservoirs, we shall refer only to Norris, the oldest tributary reservoir in the system. Data on other TVA reservoirs is extensive but including it would go far beyond the proprieties for a panel paper. Besides, Norris is a representative tributary reservoir. Its statutory purpose, like that of all TVA reservoirs, is to provide for navigation, flood control, power, and national defense.